INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	PRINCIPLES OF DISTRIBUTED EMBEDDED SYSTEMS				
Course Code	BESB06				
Programme	M.Tech				
Semester	I	EMBEDDED SYSTEMS			
Course Type	PROFESSIONAL CORE ELECTIVE				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Dr. S. Vinoth, Associate Professor, ECE				
Course Faculty	Dr. S. Vinoth, Associate Professor, ECE				

I. COURSE OVERVIEW:

This subject deals with the importance of real time communication systems, classification of real time systems, real time operating systems and the design of real-time protocols are also highlighted. Protocols, such as the CAN (Control Area Network) system should provide a predictable service to the application tasks of distributed real-time applications. This Course can be used by professionals in the industry, the relevance of the latest scientific insights to the solution of everyday problems in the design and implementation of distributed and embedded real-time systems.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Pre-requisites	Credits
UG	-	-	-	-

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
PDES	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✘	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

Each theory course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIE during the semester, marks are awarded by taking average of two session examinations.

Semester End Examination (SEE): The SEE shall be conducted for 70 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE UNITS and each UNIT carries equal weight age in terms of marks distribution. The question paper pattern shall be as defined below. Two full questions with 'either' 'or' choice will be drawn from each UNIT. Each question carries 14 marks. There could be a maximum of three sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
30 %	To test the analytical skill of the concept.
20 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):

For each theory course the CIA shall be conducted by the faculty/teacher handling the course as given in Table 4. CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Technical Seminar and Term Paper	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 9th and 17th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one-mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:

Two seminar presentations are conducted during I year I semester and II semester. For seminar, a student under the supervision of a concerned faculty member, shall identify a topic in each course and prepare the

term paper with overview of topic. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments/ Exams
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Guest Lectures
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Design Exercises
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid	2	Presentation on real world problems
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	1	-----
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1	-----
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	1	-----

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM EDUCATIONAL OUTCOMES ARE ASSESSED:

Program educational Outcomes (PEOs)		Strength	Proficiency assessed by
PEO 1	**Professional Skills:** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.	2	Board Lectures and Assignments
PEO 2	**Problem-solving skills:** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.	2	Ideas implementation/ Tutorials

Program educational Outcomes (PEOs)		Strength	Proficiency assessed by
PEO 3	**Successful career and Entrepreneurship:** An understanding of social awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.	2	Seminars, Projects and Technical presentation

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Understand the design principles of distributed embedded systems
II	Design CAN network based systems.
III	Understand RTOS to design embedded systems.

IX. COURSE OUTCOMES (COs):

COs	Course Outcomes	CLOs	Course Learning Outcome
CO 1	Understand Real Time Computer Systems requirements Real Time Systems and Real Time Communication.	CLO 1	Understand Real Time Computer Systems requirements Real Time Systems and Real Time Communication.
		CLO 2	Understand global time, Internal , external clock synchronization and Real Time Model
		CLO 3	Understand Real Time Communication, temporal relations and dependability
		CLO 4	Understand Power energy awareness, event triggered , rate constrained and time triggered.
CO 2	Understand and remember Operating System, Real Time Operating Systems Inter component communication	CLO 5	Understand and remember Operating System, Real Time Operating Systems Inter component communication
		CLO 6	Understand and remember task management, dual role of time , inter task interactions process input/output and agreement protocols
		CLO 7	Understand and remember error detection and importance of RTOS, System design and scheduling problem
CO 3	Understand and remember state and dynamic scheduling, system design and validation time-triggered architecture.	CLO 8	Understand and remember state and dynamic scheduling, system design and validation time - triggered architecture
CO 4	Understand and remember Can open CAN open standard object directory.	CLO 9	Understand and remember CAN open, CAN open standard object directory
		CLO 10	Understand and remember Electronic data sheets ,devices ,analyze CAN Standards
		CLO 11	Understand and remember CAN Standards and configuration files ,service data objectives and network management CAN open messages
		CLO 12	Understand and remember CAN Standards and device profile encoder, real time environment RTOS with examples of Real Time Communication.
CO 5	Analyze to understand CAN and Design CAN network	CLO 13	Analyze to understand real time system design with CAN Standards

COs	Course Outcomes	CLOs	Course Learning Outcome
	based systems with examples.	CLO 14	Analyze to understand RTOS to design Embedded Systems with examples
		CLO 15	Analyze to understand CAN and Design CAN network based systems with examples.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BESB06.01	CLO 1	Understand real time computer systems requirements real time systems and real time communication.	PO 1, PO 2, PO 3	2
BESB06.02	CLO 2	Understand global time, Internal, external clock synchronization and Real Time Model	PO 1, PO 2, PO 3, PO 4	2
BESB06.03	CLO 3	Understand Real Time Communication, temporal relations and dependability	PO 1, PO 2	2
BESB06.04	CLO 4	Understand Power energy awareness, event triggered, rate constrained and time triggered.	PO 1, PO 2, PO 3	1
BESB06.05	CLO 5	Understand and remember Operating System, Real Time Operating Systems Inter component communication	PO 1, PO 2, PO 3	2
BESB06.06	CLO 6	Understand and remember task management, dual role of time, inter task interactions process input/output and agreement protocols	PO 1, PO 2, PO 4	2
BESB06.07	CLO 7	Understand and remember error detection and importance of RTOS, System design and scheduling problem	PO 1, PO 2, PO 4	3
BESB06.08	CLO 8	Understand and remember state and dynamic scheduling, system design and validation time triggered architecture	PO 1, PO 2, PO 3	1
BESB06.09	CLO 9	Understand and remember CAN open, CAN open standard object directory	PO 1, PO 2, PO 3	1
BESB06.10	CLO 10	Understand and remember Electronic data sheets, devices ,analyze CAN Standards	PO 1, PO 2	1
BESB06.11	CLO 11	Understand and remember CAN Standards and configuration files ,service data objectives and network management CAN open messages	PO 3, PO 4	2
BESB06.12	CLO 12	Understand and remember CAN Standards and device profile encoder, real time environment RTOS with examples of Real Time Communication.	PO 1, PO 2	2
BESB06.13	CLO 13	Analyze to understand real time system design with CAN Standards	PO 1, PO 2, PO 4	2
BESB06.14	CLO 14	Analyze to understand RTOS to design Embedded Systems with examples	PO 3, PO 4	2
BESB06.15	CLO 15	Analyze to understand CAN and Design CAN network based systems with examples.	PO 2, PO 4	2

3= High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)						
	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7
CO 1	3	2	2	2			
CO 2	2	2	1	1			
CO 3	1	2	2	1			
CO 4	2		2	2			
CO 5			2	1			

XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1	2	2	2				
CLO 2	2	2	2	2			
CLO 3	2	2					
CLO 4	1	1	1				
CLO 5	2	2	2				
CLO 6		1	1	1			
CLO 7	1	1	1				
CLO 8	2	2		2			
CLO 9	1	1	1				
CLO 10	2	2					
CLO 11	2		2	2			
CLO 12	2		2	2			
CLO 13	2	2					
CLO 14	2	2		2			
CLO 15		2	2				

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1, PO2, PO 3, PO 4	SEE Exams	PO1, PO2, PO 4	Assignments	PO 1	Seminars	PO 1, PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

UNIT-I	**REAL-TIME ENVIRONMENT**
Real-time computer system requirements, classification of real time systems, simplicity, global time, internal and external clock synchronization, real time model. Real time communication, temporal relations, dependability, power and energy awareness, real time communication, event triggered, rate constrained, time triggered.	
UNIT-II	**REAL-TIME OPERATING SYSTEMS**
Inter component communication, task management and dual role of time, Inter task interactions, process input/output, agreement protocols, Error detection.	
UNIT-III	**SYSTEM DESIGN**
Scheduling problem, static and dynamic scheduling, system design. Validation, time-triggered architecture.	
UNIT-IV	**INTRODUCTION TO CAN**
Introduction to CAN open CAN open standard, object directory, Electronic data sheet and devices.	
UNIT-V	**CAN STANDARDS**
Configuration files, service data objectives, network management CAN open messages, device profile encoder.	
Text Books:	
1. Hermann Kopetz, "Real–Time systems-Design Principles for distributed Embedded Applications", Springer, 2nd Edition, 2011. 2. Glaf P. Feiffer, Andrew Ayre and Christian Keyold, "Embedded networking with CAN and CAN open", Copperhill Media Corporation, 1st Edition, 2008.	
Reference Books:	
1. Rajkamal, 'Embedded system-Architecture-Programming-Design", Tata Mc Graw Hill, 3rd Edition, 2011. 2. Frank Vahid, Tony Givargis, "Embedded System Design", John Wiley and sons, 2nd Edition, 2002. 3. Lyla B Das, "Embedded Systems-An Integrated Approach", Pearson, 1st Edition, 2013. 4. David E. Simon, "An Embedded Software Primer", Pearson Education, 1st Edition, 1999.	

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Real-time computer system requirements	CLO 1	T1:1.1,1.2 T2:1.2
2	Classification of real time systems	CLO 1	T1:1.5,1.4
3	Simplicity, global time	CLO 2	T1:3.1 T2:1.5
4	Internal and external clock synchronization	CLO 2	T1:3.4,3.5 T2:1.8

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
5	Real time model and Real time communication	CLO 3	T1:1.3,1.4 T2: 1.10
6	Temporal relations, dependability	CLO 3	T1:7.1,7.3 T2:6.2
7	Power and energy awareness	CLO 4	T1:5.6 T2:6.3
8	Event triggered architecture, rate constrained	CLO 4	T1:4.3 T2:5.2
9	Time triggered architecture	CLO 4	T1: 4.4 T2:5.3
10	Inter component communication	CLO 5	T1:4.5 T2:5.4
11	Task management and dual role of time	CLO 5	T1:4.6 T2:5.5
12	Inter task interactions	CLO 6	T1: 4.5 T2: 5.6
13	Process input/output	CLO 6	T1:4.4 T2:5.5
14	Agreement protocols	CLO 6	T1:4.6 T2:5.5
15	Failure faults and errors	CLO 7	T1:6.1,6.2 T2:5.6
16	Error detection	CLO 7	T1:4.7 T2:5.8
17	Fault-Tolerant Units	CLO 7	T1:4.7 T2:5.8
18	System design	CLO 8	T1:4.8 T2:5.9
19	Scheduling problem	CLO 8	T1:4.9 T2:5.7
20	Static and dynamic scheduling	CLO 8	T1:6.2 T2:5.6
21	Validation	CLO 8	T1:6.3 T2:5.7
22	Time triggered architecture	CLO 8	T1:8.1 T2:5.8
23	Introduction to Time-Triggered Protocols	CLO 8	T1:8.2 T2:5.3
24	Overview of the TTP/C Protocol Layers	CLO 8	T1:8.3 T2:5.2
25	The Basic CNI, Internal Operation of TTP/C	CLO 8	T1:8.4 T2:5.3
26	TTP/A for Field Bus Applications	CLO 8	T1:8.5 T2:7.5
27	Wide-Area Real-Time Systems	CLO 8	T1:14.1, 14.2
28	CAN Overview, An Introduction to CAN	CLO 9	T2: 5.2
29	Object Dictionary Organization	CLO 9	T2:5.3 R2:7.2
30	Data Type Definitions, Communication Profile	CLO 9	T2:5.4 R2:7.3
31	CAN open Devices, Object Dictionary Access Sequences	CLO 9	T2:5.5 R2:7.5
32	Using Identifiers and Objects	CLO 10	T2: 2.2 R2: 5.6

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
33	The Electronic Data Sheets (EDS)	CLO 10	T2:2.3 R2:5.7
34	Device Configuration Files (DCF)	CLO 11	T2:2.4 R2:5.8
35	Choosing the Devices and Tools	CLO 11	T2:4.1 R2:9.1
36	Accessing the CAN open Object Dictionary (OD) with Service Data Objects (SDO)	CLO 12	T2:2.2 R2:9.2
37	Handling Process Data with Process Data Objects (PDO)	CLO 12	T2: 2.1 R2: 9.1
38	Network Management (NMT)	CLO 13	T2:2.6 R1:5.1
39	CAN open Example Configurations and Exercises	CLO 13	T2:2.7 R1:5.2
40	Contents of CAN open Messages	CLO 13	T2:3.8 R1:5.5
41	Masters and Managers (DS302)	CLO 14	T2:3.1 R1:5.6
42	Device Profile for Encoder	CLO 14	T2:3.2 R1:5.4
43	Device Profile for Generic I/O (DS401)	CLO 15	T2:3.4 R1:5.5
44	Safety-Relevant Communication (DSP304, DSP307)	CLO 15	T2:3.4 R1:5.5
45	Evaluating the System Requirements	CLO 15	T2:4.1 R2:5.5

XVII. GAPS IN THE SYLLABUS-TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S. NO.	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POs	RELEVANCE WITH PEOs
1	Real time embedded system and communication.	Seminars/NPTEL	PO 1	PEO 1, PEO 2

Prepared by:
Dr. S. Vinoth, Associate Professor

HOD, ECE